NATIONAL WEATHER SERVICE

New guidance products of the Nearshore Wave Prediction System v1.3

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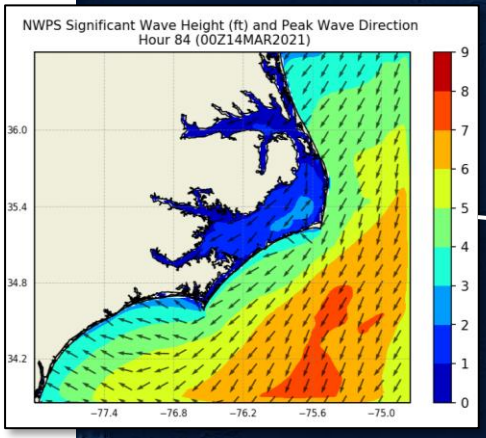
Outline

- Scope of changes in NWPS v1.3 (Feb 3, 2021)
- Unstructured mesh transition
- Wave system identification
- Hazardous rip current
- Wave runup guidance (erosion/overwash)
- Conclusions and Outlook

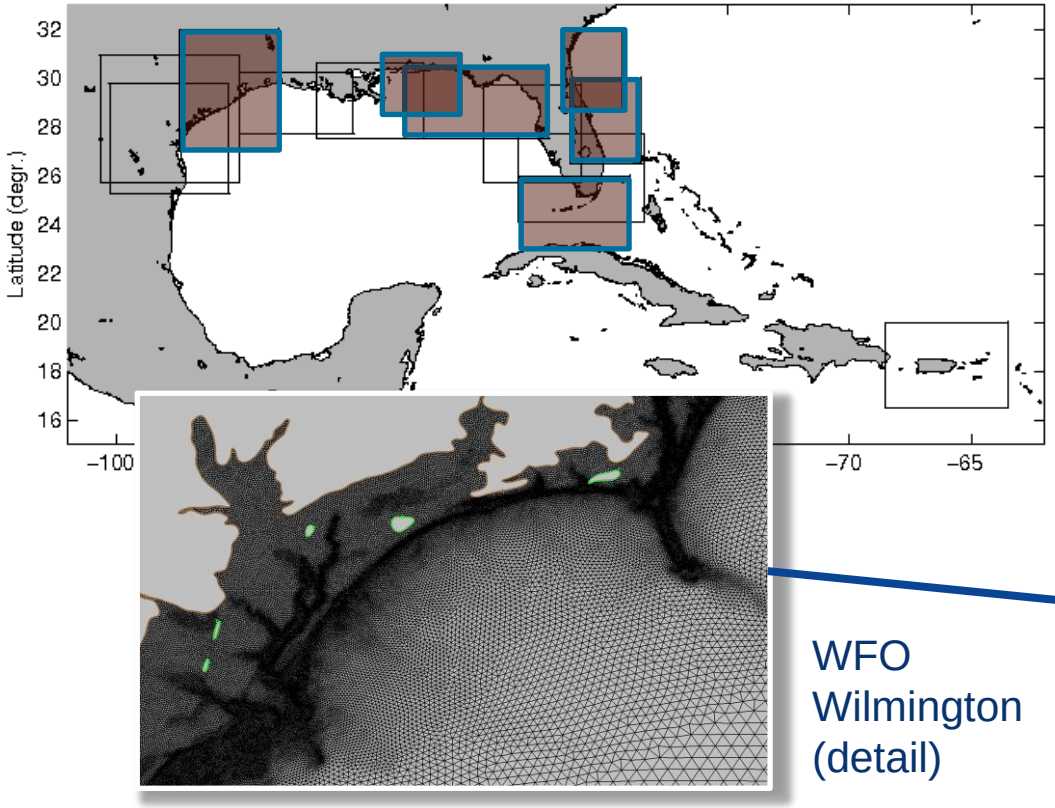
NWPS On-demand Domains (36 WFOs)



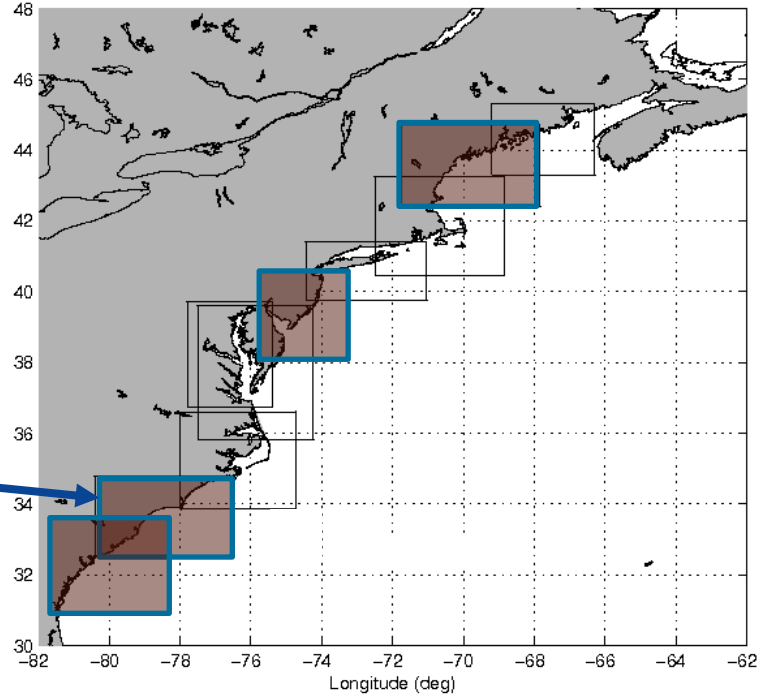
Scope of changes in NWPS v1.3
(NWS, 2021)

1. Transition 12 WFO domains from regular to unstructured grids.
2. Wave system identification using ML methods (K-means clustering). Resolved low-frequency limit lowered to 0.035 Hz.
3. Include hourly rip current guidance out to 6 days
4. Include hourly wave runup (erosion/overwash) guidance out to 6 days.
5. Improve blending of P-Surge and ESTOFS water level inputs.
6. Transect output graphics.

1. Unstructured Mesh Transition

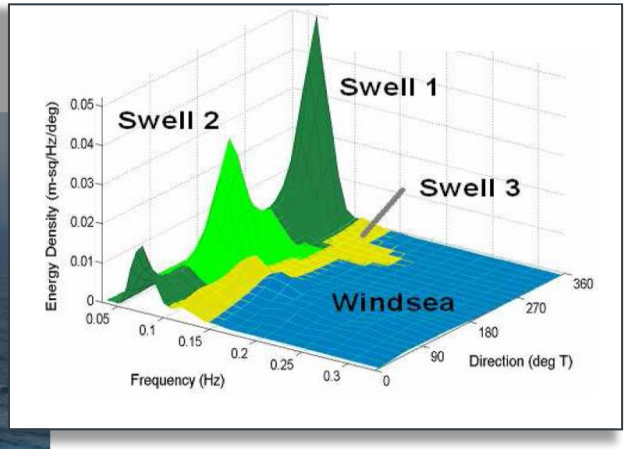


12 WFO domains transitioned
(Shaded domains, plus ALU and GUM)



WFO
Wilmington
(detail)

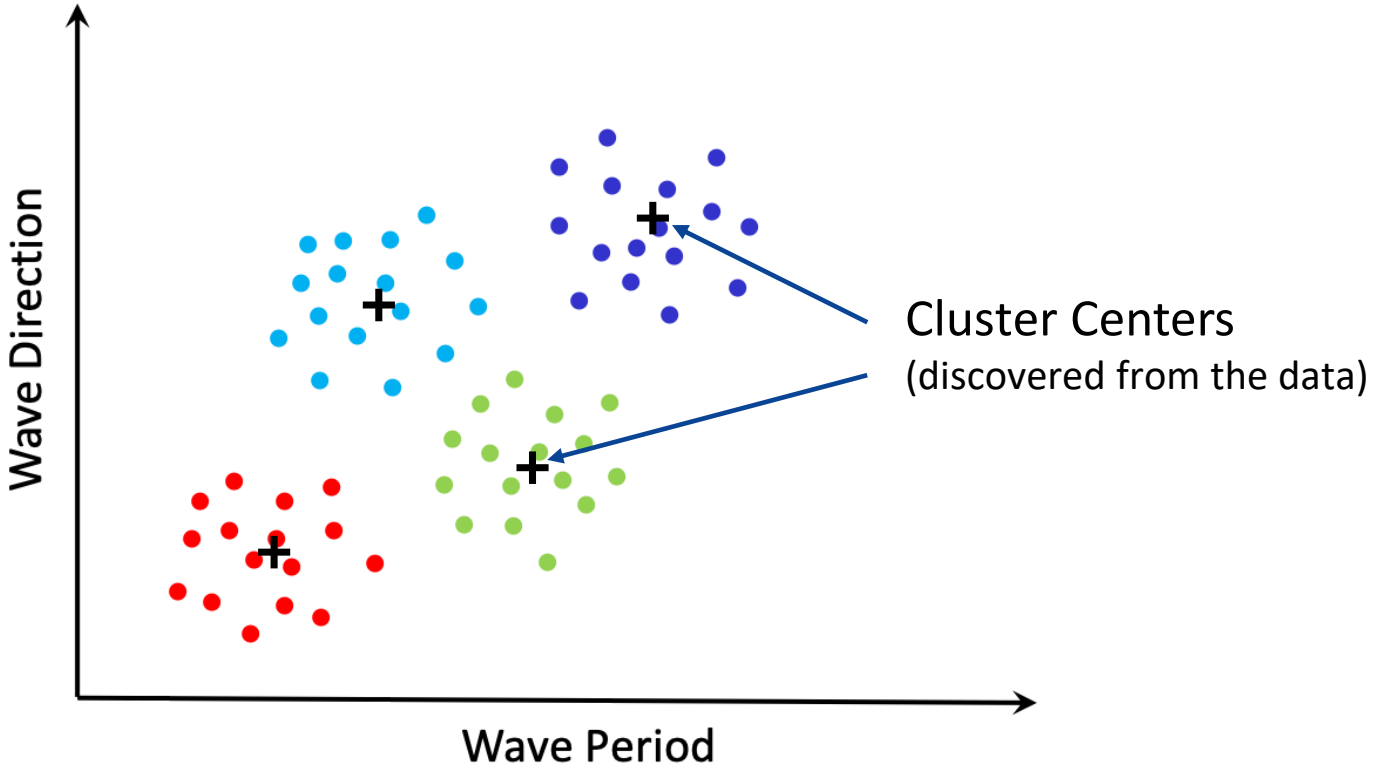
2. Wave system identification



Tracy et al. (2007)

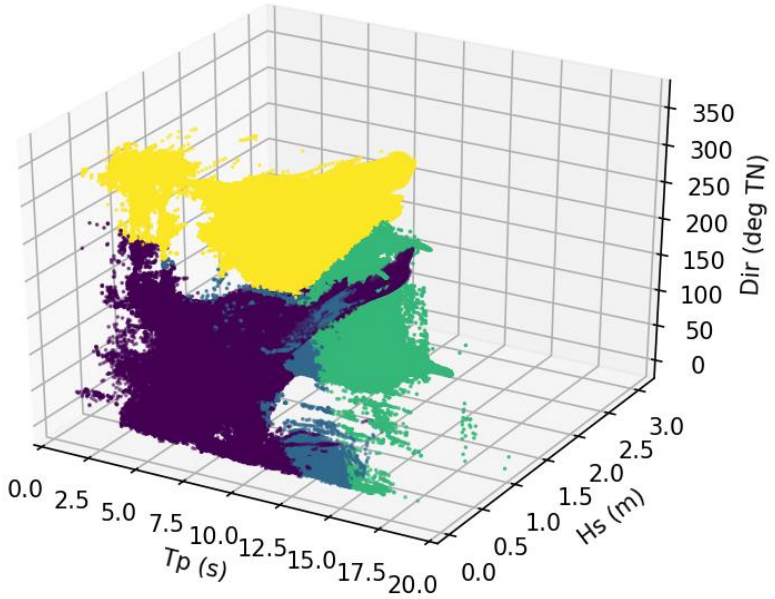
Credit: Michel Griffon, Wikipedia (no edits)

Cluster Analysis (k-means clustering)

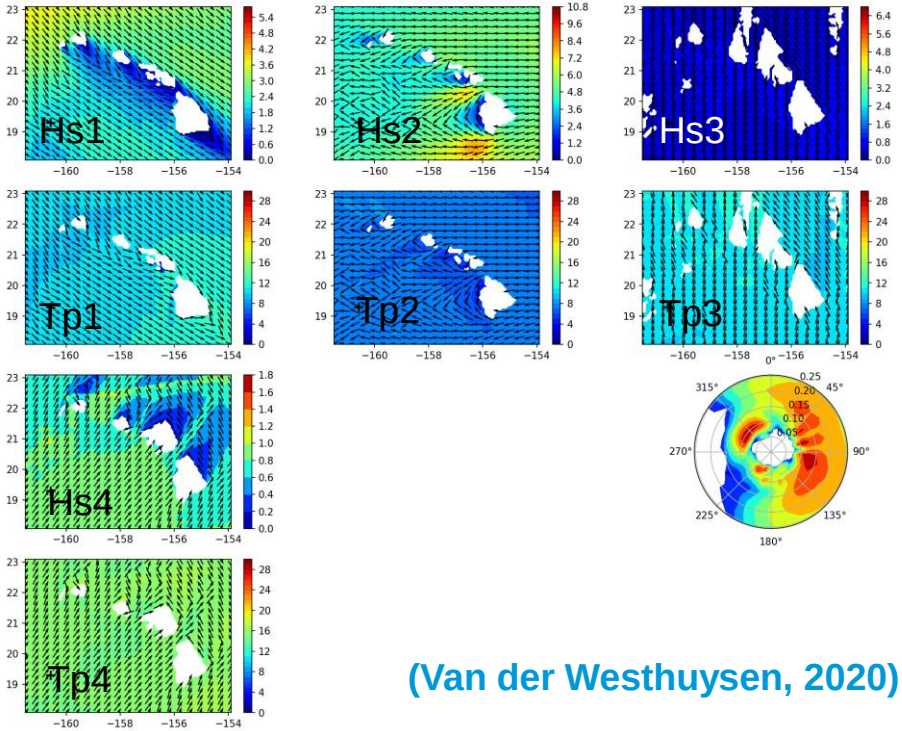


Wave systems: WFO Honolulu example

k-means clustering in parameter space

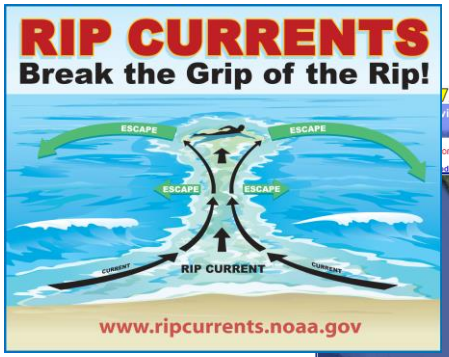


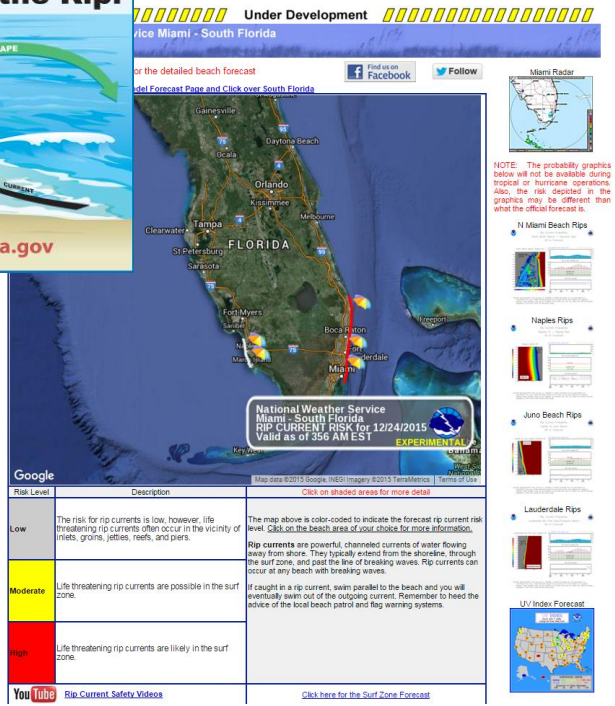
k-means clustering geographical space



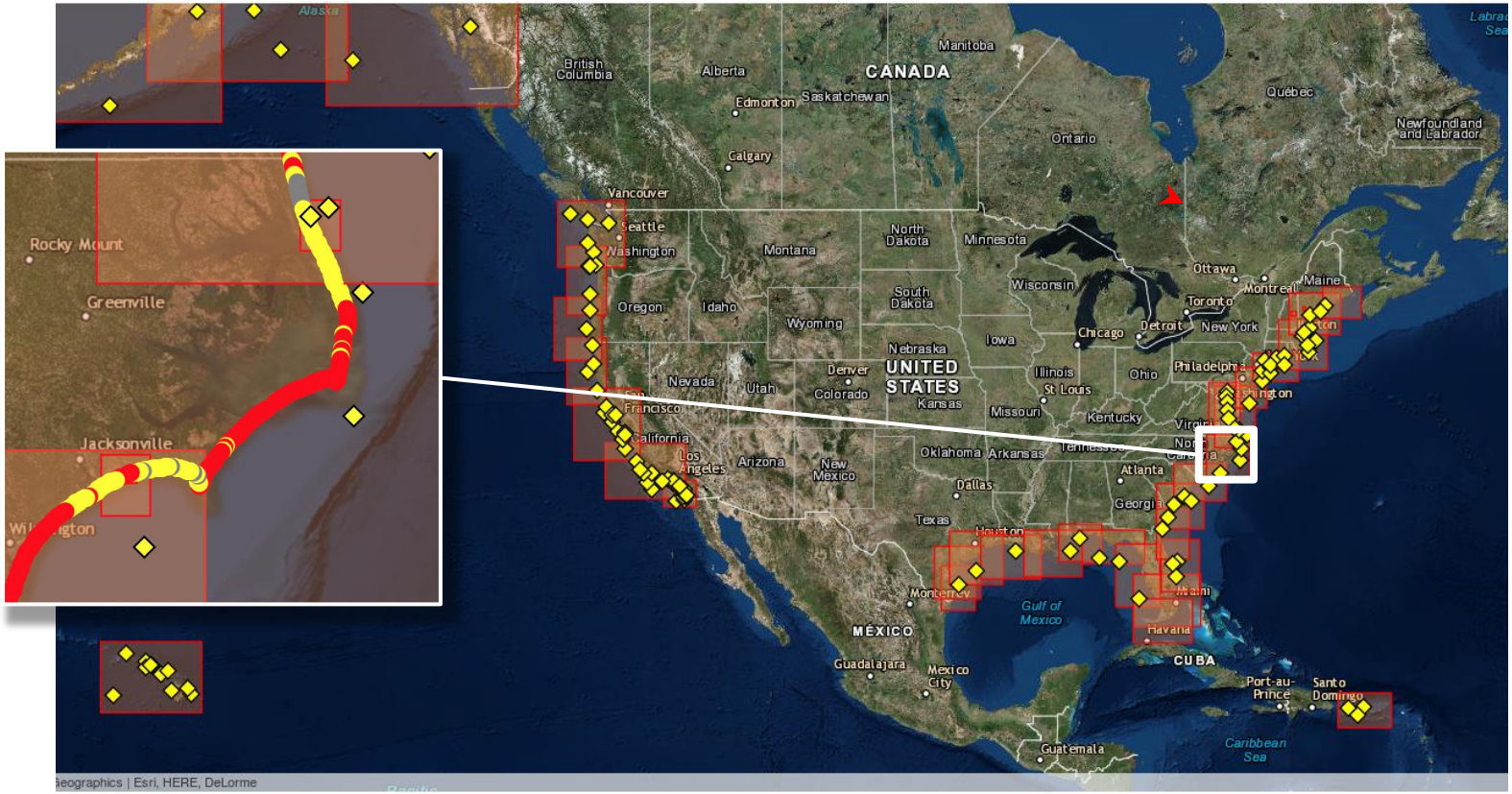
(Van der Westhuysen, 2020)

3. Hazardous Rip Current Forecasting



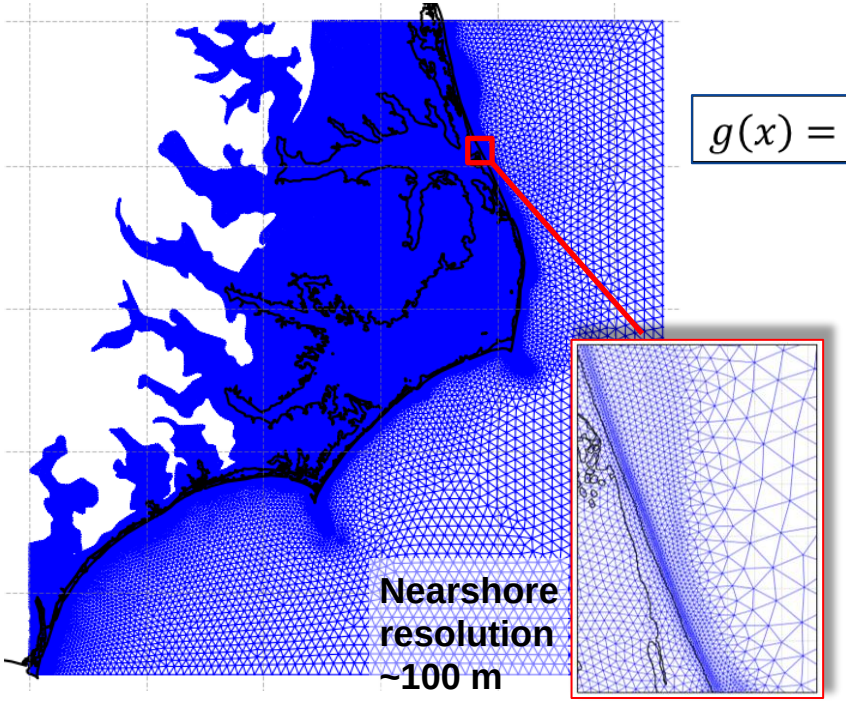


NWPS Probabilistic Rip Current guidance



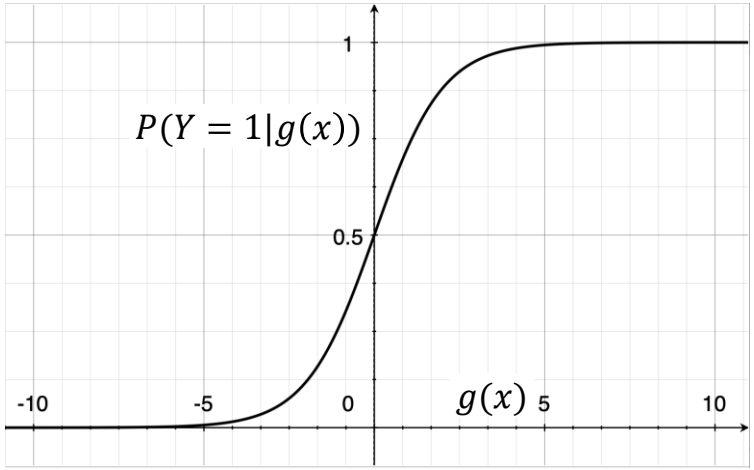
Rip Current Guidance with Logistic Regression
(Dusek & Seim, 2013)

WFO Morehead City model mesh

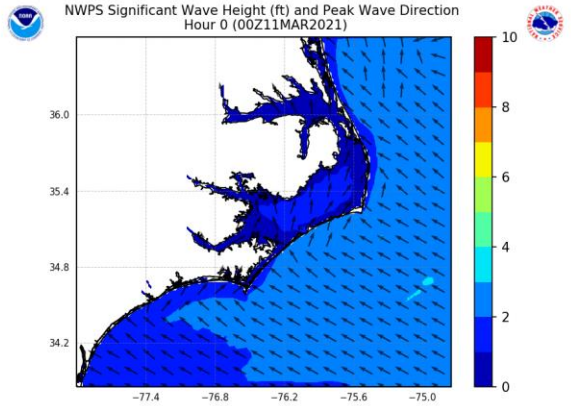


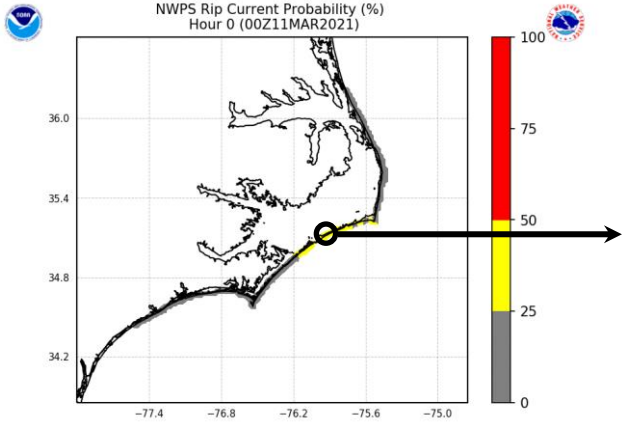
$$P(Y = 1|g(x)) = \frac{1}{1 + e^{-g(x)}}$$

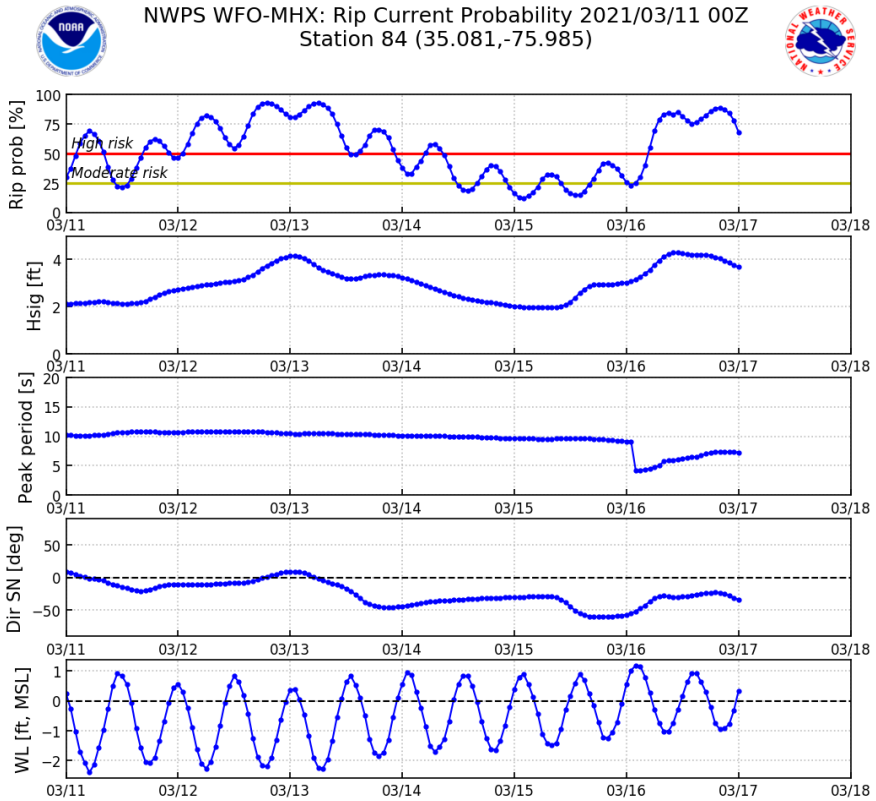
$$g(x) = 1.05 + 3.51\ln(Hs) - 0.027|\theta| + 0.42\text{Ep} - 1.70\eta$$



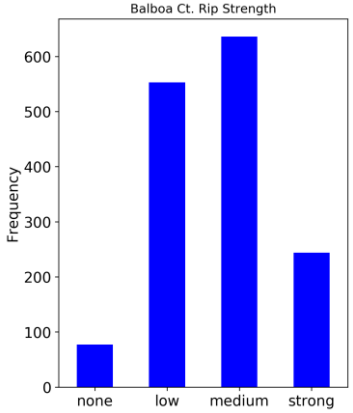
Rip Current Guidance in NWPS

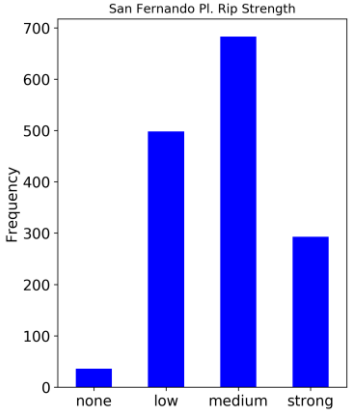


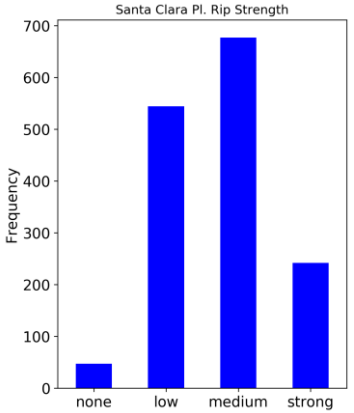




Rip Current Validation



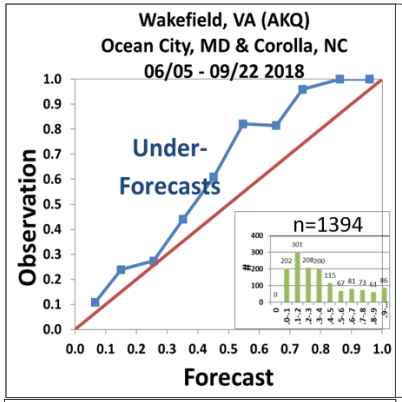


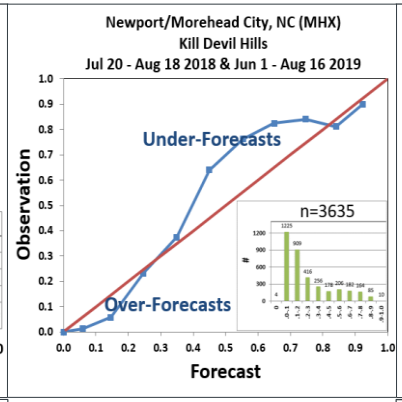


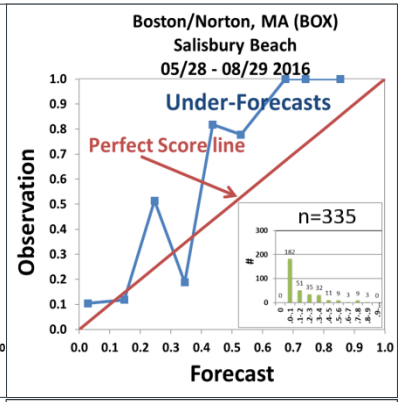
Rip Current Validation: ER example

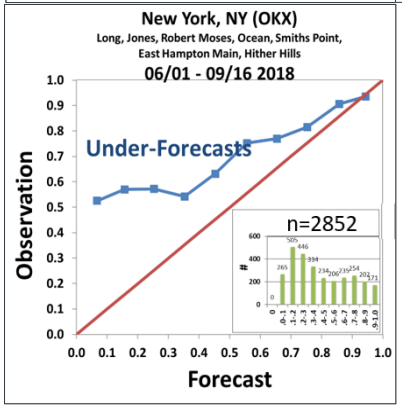
Brier Skill Scores

Weather Forecast Office	Model vs Sample Climate	Model vs traditional Rip Index
Boston/Norton, MA (BOX)	+23.5%	NA
New York, NY (OKX)	-25.8%	NA
Wakefield, VA (AKQ)	+32.4%	NA
Morehead City, NC (MHX)	+45.3%	+35.8%
Charleston, SC (CHS)	-19.3%	NA

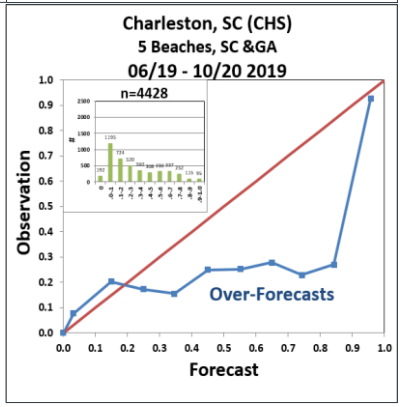






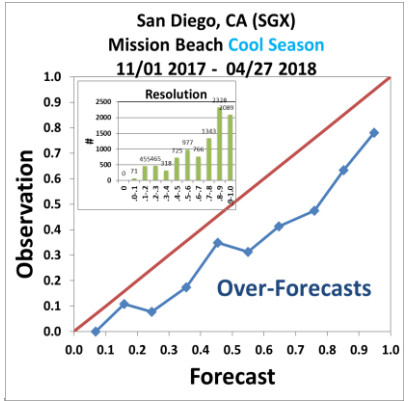


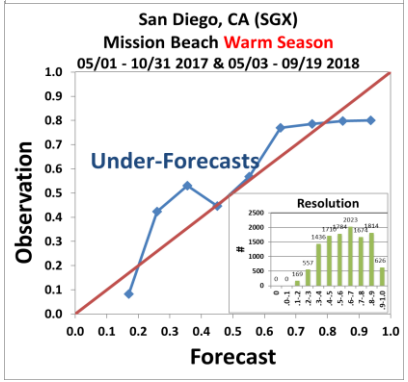
Reliability Diagrams



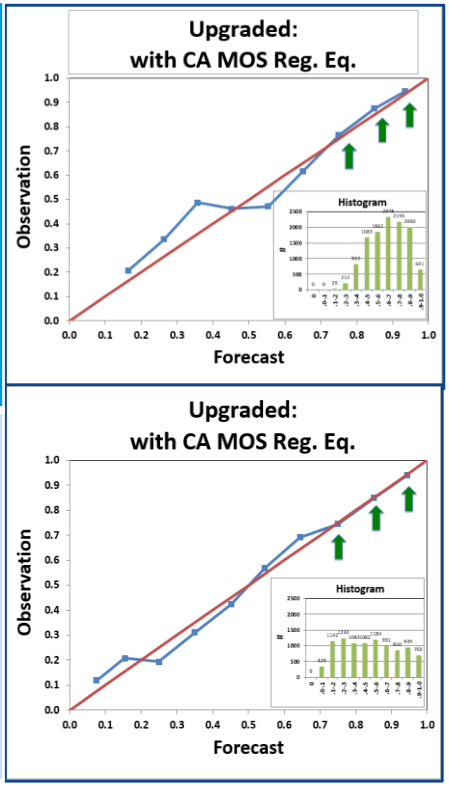
Future improvements with MDL RCMOS

- The NWPS v1.3 rip current model is not calibrated with regard to either regional or seasonal variations.
- The model is a “perfect prog” model, i.e., no corrections made for systematic biases of the NWPS model output (input to this model).
- MDL has developed new regional and seasonal MOS logistic regression model using lifeguard obs and NWPS forecast data (Im et al., 2019, 2021).
- Future versions of the NWPS rip model can be calibrated locally with RCMOS equations.





Future Model vs Sample Climate (current model)	Future Model vs traditional approach or SRF (current model)
Warm season: 12.2% (7.4%)	Warm season: 32.3% (27.1%)
Cool season: 26.8% (3.7%)	Cool season: 15.7% (-8.8%)



Current model

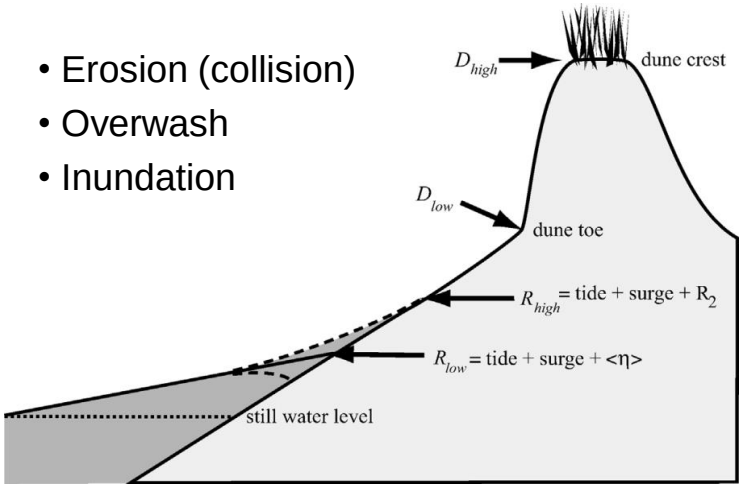
(Im et al., 2019)

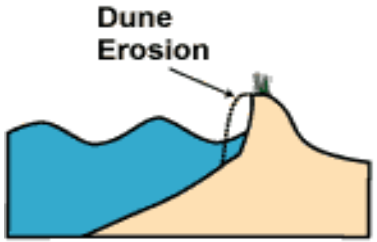
4. Wave runup guidance (Stockdon et al. 2006)

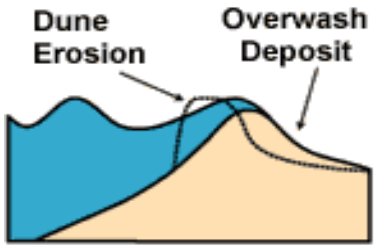
$$R_2 = \text{Setup} + \text{Swash}/2$$

$$= 1.1\left(0.35\beta_f (H_0 L_0)^{1/2} + \frac{[H_0 L_0 (0.563\beta_f^2 + 0.004)]^{1/2}}{2}\right)$$

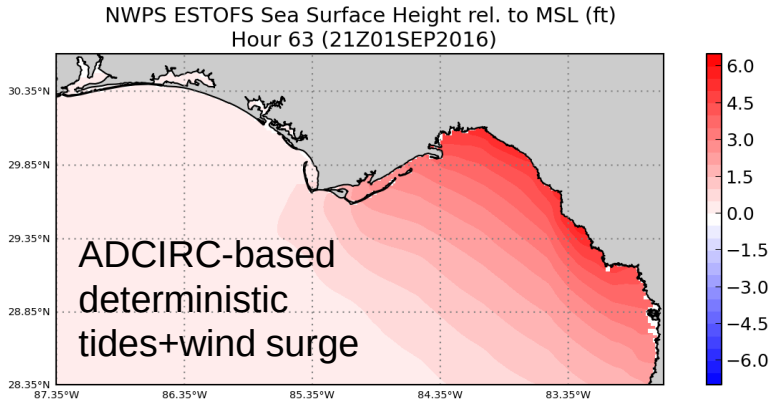
- Erosion (collision)
- Overwash
- Inundation

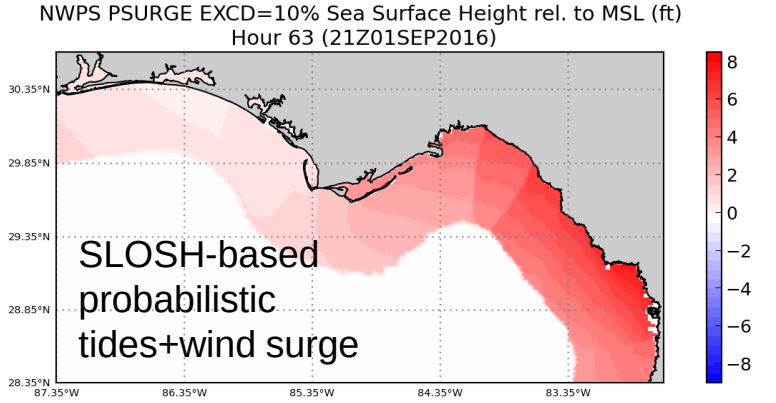


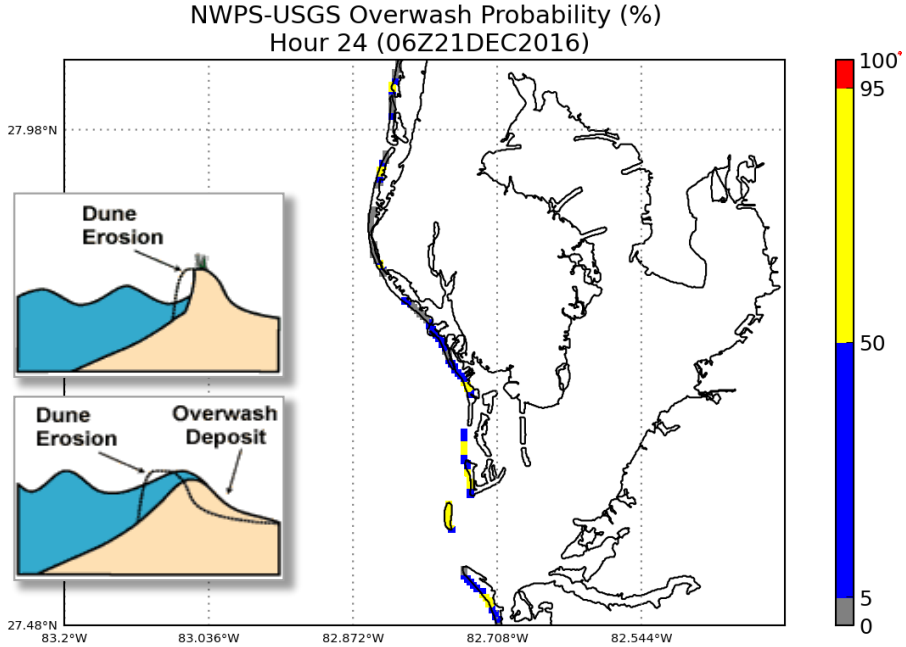




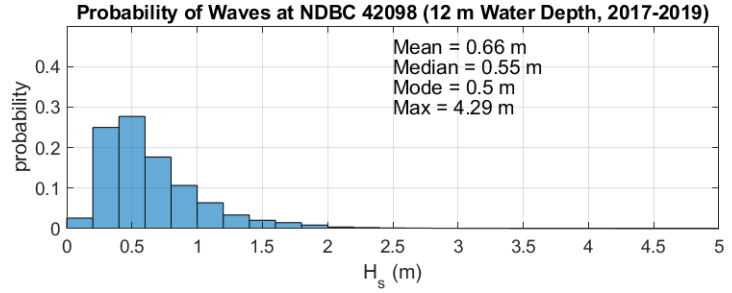
Gridded runup guidance (e.g. WFO Tampa)

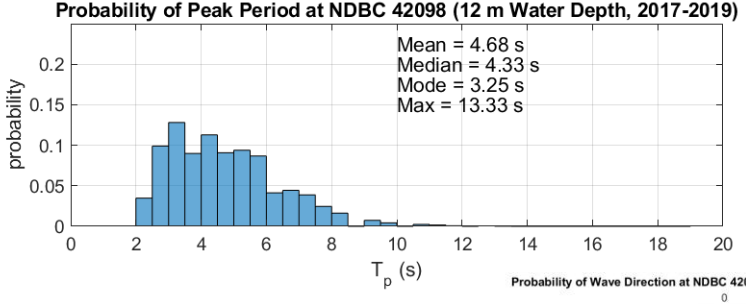




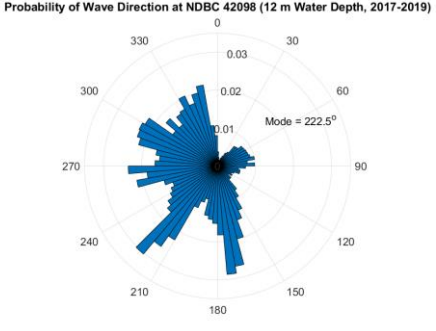


Wave Runup Validation: Experimental Site





Tidal range = 0.8 m

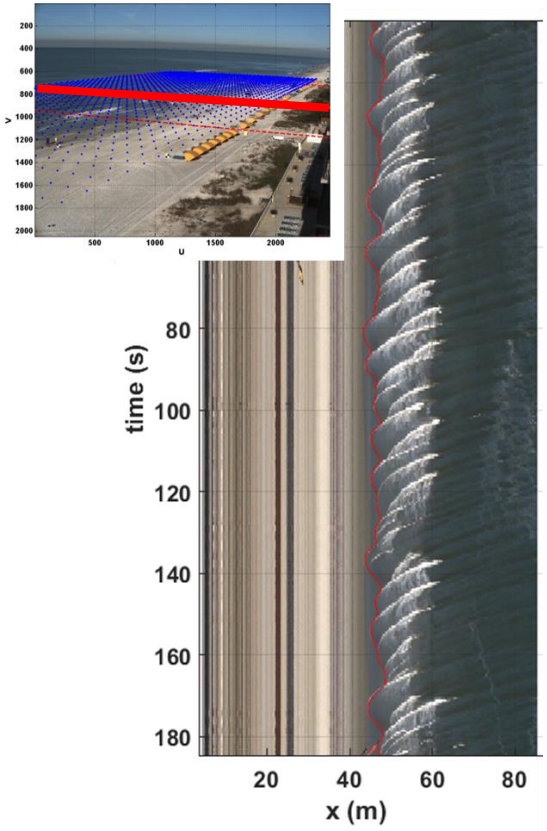


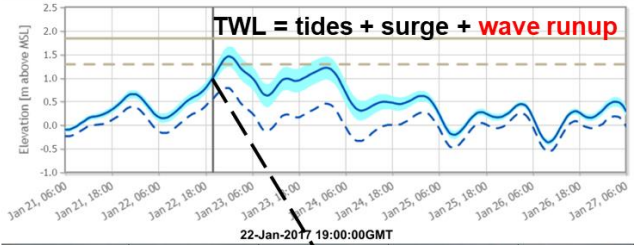
USGS CoastCam; Madeira Beach, FL; Jan 2017-Present

USGS
science for a changing world

Wave Runup: Image processing and validation

- Camera calibrated
- Video down-sampled to a cross-shore transect
- Wave swash edge is digitized and projected into real-world coordinates
- Observed elevation of TWL compared to forecast





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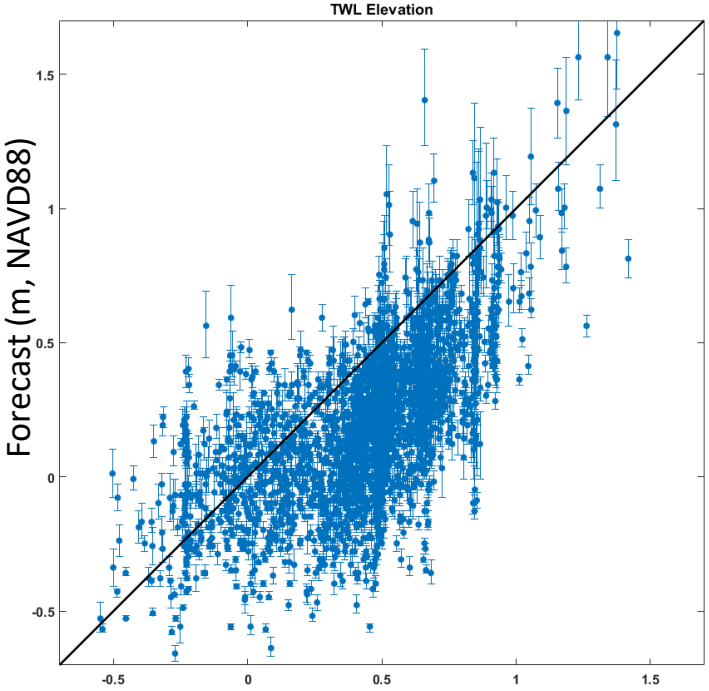
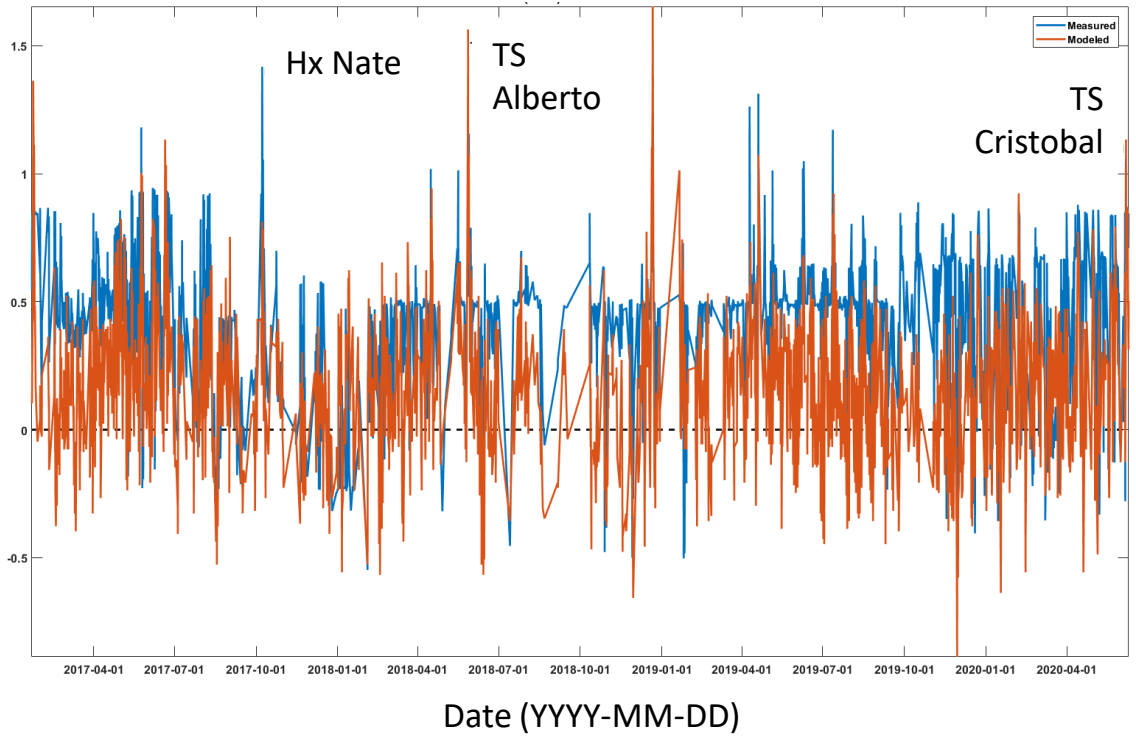
Wave Runup: Forecast validation (2017/01-2020/06)





USGS science for a changing world

Bias = -0.24 m, RMSE = 0.34 m, R^2 = 0.38

Conclusions and Outlook

1. NWPS v1.3 features new and improved guidance on wave systems, hazardous rip currents and erosion/overwash.

2. The rip current model performed well at most locations, but not all:
   - In NWPS v1.3, a single equation from the North Carolina “perfect prog model” has been applied to all WFOs, without local tuning.
   - No bias correction has been applied to inputs.
   - Model coefficients can be fit locally and seasonally (Im et al., 2019).
   - Different and additional sets of predictors to be investigated.
   - Quality of observations can be improved.

3. The wave runup model performed well at single long-term monitoring station. Future enhancements include:
   - Expand validation by adding remote sensing stations to more locations.
   - Introduce additional expressions for different shore types (e.g. rubble mound).

References

Dusek, G. and H. Seim, 2013. A probabilistic rip current forecast model. Journal of Coastal Research. 29(4). 909-925.

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